Rogers Cow Camp Salvage Project
Soils and Watershed Input

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Soil and Watershed Actions

There is a need to improve roads to reduce the amount of sediment that reach streams. The 22N40X and its associated landing have been identified as needing some improvements. Table 1 describes needs and the way the issues will be resolved. An unclassified road was identified in the project and was given the following road ID UC-220609-01. There is a need to decommission this road because of minor hydroconnectivity and the long-term issue that the stream crossing may blowout in the future. UC-220609-01 is an unclassified road so maintenance will not occur at all, so it possesses a potential threat of depositing the road fill into the steam when it does blowout. 23N15 was identified as a problem because its partially plugged.

Table 1. Worklist for Improving Water Quality

Road ID	Description of issues and treatments
23N15	Ephemeral stream crossing is partially plugged. Needs maintenance. Remove spoils from site so wont reenter stream.
22N40X	Approximately 400 ft of the road needs dips or waterbars to stop rills on road that eventually connect to the 22N40XB. The potential for hydroconnectivity to a tributary to Haphazard Creek exists.
22N40X-Landing	A landing at the end of 22N40X is depositing sediment into an ephemeral stream. Recommend stabilizing landing/dispersed camp site. Options include to fell some trees and place them to create a catch basin. Place some coir logs to help stabilize key locations. Add ground cover at above and below landing which may include weed free straw and/or planting native grasses/plants.
UC-220609-01	Decommission unclassified road. Unclassified road segment is approximately 1600 ft (0.3 miles). Evidence of past unauthorized dirt bike use. • Culvert at stream crossing will be removed. Site will have banks pulled back to a stable slope and soil cover will be added. Approaches to the stream will have waterbars and/or the road ripped cross contour, so no sediment reaches the stream. • Three ditch relieve culverts will be removed. One of the ditch relive culverts is located at a seep/spring. Removal of cross drains and ripping of the road bed will occur when stream flow is minimal.

Other treatments not discussed in Table 1 that would be done is general road maintenance which includes cleaning inside ditch, cleaning ditch relieve culverts, blading road surface, and cleaning the inlets and outlets of stream crossings. There are no proposed soil restoration activities.

Restrictions/Design Features

- All skid trails and temporary roads will have waterbars as erosion control features.
- Adhere to FS-990a National Best Management Practices for Water Quality Management on National Forest System Lands, Volume 1: National Core BMP Technical Guide (April 2012), in particular:
    - Mechanical Vegetation Management Activities: Veg 1-4 (especially Veg -3, Aquatic Management Zones), 6, and 8; pgs. 128-140.

- Adhere to R5 FSH 2509.22 Soil and Water Conservation Handbook, Chapter 10 Water Quality Management Handbook, Amendment # 2509.22-2011-1 (Dec 05, 2011). In particular, BMPs 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.8, 1.9, 1.10, 1.11, 1.12, 1.13, 1.14, 1.15, 1.16, 1.17, 1.19, 1.20, 1.21, 2.2, 2.3, 2.4, 2.5, 2.6, 2.8, 2.11, 5.1, 5.2, 5.4, and 5.6.
- More design specific design features are in the project's file that contains all the resources' design features/mitigations. Below are some of the most crucial for soils and watershed.
    - See Table 2 for the RCA Heavy Equipment Exclusion Zone
    - Limiting Operating Period (LOP) (BMP 1-5, BMP 1-13) for soil moisture.
        - Conduct ground-based harvest operations when soil is dry; that is, in the spring when soil moisture in the upper 8 inches is not sufficient to allow a soil sample to be squeezed and hold its shape or will crumble when the hand is tapped. In the summer and early fall after storm event(s) when soil moisture between 2-8 inches in depth is not sufficient to allow a soil sample to be squeezed and hold its shape or will crumble when the hand is tapped. Work on streams should occur during low flow (late summer)
    - If effective soil cover is below the desired level of soil cover along streams, then leave slash material to increase soil cover. When cutting trees lop and scatter broken tops and limbs within 1 tree length of any stream.
    - If effective soil cover is below the desired condition of 50 percent, minimize the amount of slash taken to landings. Were feasible scatter slash to increase coverage.
    - Skid trails should add ground cover/slash between its waterbars and the outlets of the waterbars. Effective soil cover percentages should be 50 percent between waterbars and 70% at waterbar outlets.
    - Fuel outside of riparian areas. 300 feet on perennial and 150 feet on seasonal flowing streams.
        - BMP 2.11 (Equipment Refueling and Servicing) will prevent fuels, lubricants, cleaners, and other harmful materials from discharging into nearby surface waters or infiltrating through soils to contaminate groundwater resources.

Table 2. RCA Heavy Equipment Exclusion Zone Widths and Slope Restrictions

Stream Type	Equipment Exclusion Zone (EEZ) for Salvage, Yarding, and Machine Piling of Slash[1]		Mastication	Underburn[2]	Hand Cut[3]	Minimum Distance to Burn Piles
	Slope <35%	Slope >35%				
Perennial streams	100 feet	Excluded	50 feet	150 feet	No buffer	25 feet
Intermittent streams	100 feet	Excluded	50 feet	150 feet	No buffer	25 feet
Ephemeral streams	50 feet	Excluded	25 feet	150 feet	No buffer	25 feet
Special Aquatic Features (Reservoirs, wetlands, fens, and springs)	100 feet	Excluded	50 feet	150 feet	Perimeter	25 feet
Riparian Features: dry meadows, seasonal wetlands	0 to 25[4]feet	Excluded	25 feet	150 feet	Perimeter	25 feet

1. No reaching in within the zone to remove felled trees. Fell trees away from the stream.
2. Prescribed burning would be allowed within RCAs, but there would be no ignitions in riparian vegetation. Fire may back

through this zone.
3. May hand cut within RCA feature but don't cut riparian vegetation. Don't cut vegetation that provides stream bank stabilization. Adhere to the minimum distance for burn piles. No hand cutting within special aquatic features and riparian features unless marked by hydrologist and/or biologist.
4. Meadows may have no buffer to a 25 ft. buffer depending on the individual meadow. Buffers may vary due to the condition of the meadow (i.e. meadow is encroached with trees).

Hydrology Analysis

Protection of water quality and quantity is an important part of the Forest Service's mission (USDA Forest Service 2007). Management activities on national forest lands must be planned and implemented to protect the hydrologic functions of forest watersheds, including the volume, timing, and quality of streamflow. The Clean Water Act of 1948 (as amended in 1972 and 1987) establishes as federal policy the control of point and non-point source pollution and assigns to the States primary responsibility over control of water pollution. The Forest Service is required to protect and enhance existing and potential beneficial uses during water quality planning (California Regional Water Quality Control Board [CRWQCB], 1998). Compliance with the Clean Water Act by national forests in California is achieved under state law (see below). Beneficial uses are defined under California State law to protect against degradation of water resources and to meet state water quality objectives. The 1988 Plumas National Forest Land and Resource Management Plan states: "maintain or, where necessary, improve water quality using Best Management Practices (BMPs)". BMPs are procedures, techniques, and mitigation measures that are incorporated in all Plumas National Forest actions to protect water resources and prevent or diminish adverse effects to water quality. Subsequent Forest Plan standards and guides' state: "implement BMPs to meet water quality objectives and improve the quality of surface water on the Forest."

Direct and Indirect Effects of Vegetation Management Activities

The primary treatment is to salvage the tress in those areas affected by the 2020 North Complex Fire via mechanical thinning. Mechanical thinning will occur in RCAs and will be limited to those buffers as described in Table 2. In areas that have effective soil cover below 50 percent, have the broken tops and limbs left in place. When cutting trees lop and scatter broken tops and limbs within 1 tree length of any stream. These design features will help improve effective soil cover.

The hand cutting of conifers up to 10 inches in DBH in the equipment exclusion zone will reduce the canopy cover for smaller tree size classes. But it will not drastically change the overall canopy cover because of overlapping canopy of the bigger tree size classes. Canopy cover is an important component for water temperature of streams and the micro climate of meadows. The defined equipment exclusion zones are designed to be effective for buffering/filtering any potential surface runoff due to the mechanical thinning. It is discussed in the soils section, decreases in effective soil cover post-implementation are not significant. But if a unit were not to meet the project standard of 50 percent for effective soil cover than the design feature to increase effective soil cover would be implemented. Other BMPs will help minimize the potential for surface runoff from reaching any stream. Some of these BMPs include: 1.8 Streamside Management Zone designation, 1.9 determining tractor-loggable ground, 1.12 log

landing location, 1.16 log landing erosion control, 1.17 erosion control on skid trails, and 1.19 erosion-control structure maintenance.

Mastication is a treatment that is unlikely to produce additional surface runoff because the treatment creates more surface soil cover, which is good at slowing down runoff. The goal of masticating is that it takes the ladder fuels and it rearranges them to surface fuels. The masticator equipment will be limited by the equipment exclusion zone along RCAs as identified in Table 2. Within the equipment exclusion zone hand cutting of conifers up to 10 inches in DBH would be allowed and the piles would be place 25 feet away from any stream bank. Masticating along RCAs will not change water quality and its beneficial uses.

Hand cutting within the entire stream allocation area regardless of the type of stream will be allowed. Burn piles may be ignited independent of an underburn. Piles should be at least 25 ft. from the edge of stream bank. Hand cutting would be allowed up to the meadow's perimeter and within. Piles maybe piled within the meadow. Hand cutting up to the springs will be allowed but the piles should be 25 feet away. Hand cutting conifers up to 10 inches in DBH applies across the entire project regardless if it's in or out of an RCA. The hand treatment within RCAs will not change the water quality or its beneficial uses because the activity does not significant change effective soil cover to promote erosion or the canopy to change the water temperature of steams. The hand cut pile burn treatments within RCAs are intended to help reduce the fuels before underburning the RCAs. Grapple piling of the hand cut material is purposed but it will be limited by EEZ and will adhere to design features. The grapple piling treatment is not expected to cause any significant effect to the beneficial uses of the project's waters.

Grazing will be allowed as alternative treatment to prescribed fire (underburn) and/or hand cut pile within RCAs. The goat grazing will be allowed within entire RCA area. The goats would primarily target live understory that they can reach and not eat the soil cover unless its some type of grass. A reduction in soil cover is not expected nor erosion that would affect water quality.

Underburn will be allowed within the RCAs. Fire will be ignited no closer than 150 ft. away from any stream, spring, and meadow. Underburn will be allowed to back into these features under the ideal conditions. Underburning in this project is a secondary or thirdly treatment type. The BMP Evaluation Program from 2010-2012 found that prescribed fire (F25) BMPs were rated at 100 percent for implementation and 97 percent for effectiveness (USDA Forest Service 2013). The high success rate of implementation and effectiveness of BMPs when conducting underburns means that the Forest Service met or exceed project identified effective soil cover, and little or no hydrophobic soils and rilling was observed. The utilization of BMPs, design features and proper buffers for RCAs is crucial to treating within RCAs; this would make them more fire resilient yet not jeopardize the RCAs and its associated beneficial uses.

Miles of Road Improved and Maintained

Road surveys were in the months of June and July 2021. Thirteen Forest Service system roads were surveyed for a total of 10.6 miles. The road surveys primarily looked at the stream crossings for hydrologic issues. A total of 27 culvert stream crossing and 33 low water crossings were assessed. No

major issues were found except one stream crossing was partially plugged. The other issues where hydroconnectivity not associated with an actual stream crossing. Table 1 identifies 22N40X and its associated landing as needing to be stabilized to improve water quality. UC-220609-01 is an unclassified road that was identified as a future problem if the stream crossing blows out and its road fill is washed down the stream. Decommissioning UC-220609-01 will eliminate the issue.

Direct and Indirect Effects of Chemical Treatments

The possible routes by which herbicides may contaminate water would be direct application, drift into streams from spraying, runoff form large rain event soon after application, and leaching through the soil into ground water or into a stream. This section addresses each of these delivery routes. No direct application of herbicide to water is proposed for this project. General characteristics for the proposed herbicides are displayed in Table 3. These were compiled from the label information and SERA Risk Assessments.

Table 3. Herbicide Behavior in Soils and Water.

Chemical	Environmental Fate and Hazards	Leaching Potential	Runoff Potential	Soil Half-life (days)
Glyphosate	Adsorbs tightly to soils. Subject to rapid microbial degradation. Non-toxic to soil microorganisms. Low drift potential.	Low	Low	47
Triclopyr	Weakly bound to soils. Potential for off-site movement through drift, runoff, and wind erosion. Relatively non-toxic to soil organisms.	Low	Moderate	46

The buffers in Table 4 are for the most part greater than what has been done on other projects on the Plumas National Forest. These buffers are more restrict because it's a post fire reforestation project and will adhere to the Water Discharge Requirements General Order R5-2017-0061 (herein referred to as General Order) set by the California Regional Water Quality Control Board for the Central Valley Region.

Table 4. Stream and Aquatic Features Buffer Widths for Herbicide Application

Herbicide Active Ingredient	Perennial or intermittent streams that have fish always or seasonally present.		Perennial or intermittent streams that have that don't have fish.		Ephemeral streams and meadows	
	Percent Slope					
	<30	30-50*	<30	30-50*	<30	30-50*
Glyphosate	75 ft.	100 ft.	50 ft.	75 ft.	25 ft.	50 ft.
Triclopyr-TEA	100 ft.**	100 ft.	50 ft.	75 ft.	25 ft.	50 ft.

Buffer distances are measured from the water's edge.
Roadside ditches will be treated the same as the water body type they resemble.
*Where management activities are planned on a burned area with slopes greater than 30%, a minimum of 50% average effective groundcover (see Attachment C for guidance) is required to be documented prior to pesticide application. Documentation shall be provided to the Central Valley Water Board in the pesticide notification 30 days prior to application.
**Buffer was increased from 75ft. to 100 ft. for wildlife concerns.

The two herbicides would be used with adjuvants such as surfactants which break up the surface tension of the herbicide and increase the ability for plants to absorb the herbicide. Since any surfactants used would be mixed as a small percentage of an herbicide, the effects on the environment, including

soils and water quality would the same as the herbicide (Bakke 2007). Dyes would be used in the herbicide application to identify areas treated and reduce the chance of misdirection spray. Dyes or similar biodegradable colorant to facilitate visual control are water soluble dye and contains no listed hazardous chemicals. They are considered virtually non-toxic to humans (Bakke 2007). For the remainder of this analysis, the discussion of effects resulting from herbicide application takes into consideration the effects of herbicides active and inert ingredients, metabolites, surfactant, and marker dye.

Table 5. Herbicide Application Design Features

Design Feature	Soil and Water Design Standards	Purpose of Design Standard	Source of Design Standard
DF-1	Areas with bare soil created by the herbicide treatment would be evaluated for rehabilitation (i.e. reseeding, mulching, etc.)	To ensure that reforestation is not creating open and bare areas that may cause sediment to enter a stream which could affect water quality and riparian habitat.	BMP 5.4: Revegetation of Surface-disturbed Areas (R5-FSHB 2509.22)
DF-2	**Areas outside of ephemeral stream**: If treatment reduces soil cover to less than 50% for a contiguous are of >0.25 acres, then mulching and/or revegetation may be required to minimize erosion and reestablish native vegetation. Only native plant species will be used in revegetation. All mulch and seed material will be certified weed-free. **Areas within 50 feet of ephemeral stream**: If treatment reduces soil cover to less than 50% for a contiguous area of >0.1 acres, then mulching and/or revegetation may be required to minimize erosion and reestablish native vegetation. Only native plant species will be used in revegetation. All mulch and seed material will be certified weed-free.	To ensure that reforestation is not creating open and bare areas that may cause sediment to enter a stream which could affect water quality and riparian habitat.	BMP 5.4: Revegetation of Surface-disturbed Areas (R5-FSHB 2509.22)
DF-3	Herbicide mixing will not occur within 150 feet of the ephemeral stream and inside ditch. The cleaning and disposal of herbicide containers will be done in accordance with Federal, State, and local laws, regulations, and directives.	To reduce risk of contamination of water by accidental spill.	BMP 5.10: Pesticide Soil Contingency Planning (R5-FSHB 2509.22) BMP 5.11: Cleaning and Disposal of Pesticide Containers and Equipment (R5-FSHB 2509.22) National BMP Chem-5: Chemical Handling and Disposal (FS-990a)
DF-4	When applying herbicides with a backpack sprayer all directed spray will be done in a downward direction in accordance to the herbicide's label. This will minimize herbicide drift and confine the herbicide to the drop zone of the individual weed plant being treated.	To control drift within the entire project area especially within sensitive areas and near water.	BMP 5.12: Streamside Wet area Protection during Pesticide Spraying (R5-FSHB 2509.22) BMP 5-13: Controlling Pesticide Drift During Spray Application (R5-FSHB 2509.22) National BMP Chem-1: Chemical Use Planning (FS-990a)
DF-5	All herbicide application will follow EPA approved label directions in regards to control	To control drift of herbicides onto unintended targets and	BMP 5.8: Pesticide Application According to

Design Feature	Soil and Water Design Standards	Purpose of Design Standard	Source of Design Standard
	of drift of herbicides during spraying. These directions have specific wind speeds and air temperatures for application of each herbicide. Applicators will utilize droplet size and spray pressure to insure droplets do not travel outside of the drip line target plant. A colorant would be added to the herbicide mixture prior to spraying. Spray cards may be used to aid in detecting herbicide drift.	to minimize risk of surface water contamination.	Label Directions and Applicable Legal Requirements (FSHB 2509.22) BMP 5.9: Pesticide Application Monitoring and Evaluation (R5-FSHB 2509.22) BMP 5.13: Controlling Pesticide Drift during Spray Application (R5-FSHB 2509.22) National BMP Chem-2: Chemical Use Planning (FS-990a)
DF-6	POEA surfactants will not be used within 150 feet of live waters.	To protect aquatic organisms.	BMP 5.12: Streamside Wet area Protection during Pesticide Spraying (R5-FSHB 2509.22)
DF-7	Roadside ditches will be treated the same as the water body type they resemble.	To project water quality and meet SNFPA Riparian Management Objectives. Also, to ensure that TECS and Special Interest plants are protected.	BMP 5.12: Streamside Wet area Protection during Pesticide Spraying (R5-FSHB 2509.22)

The design features listed in Table 5 were designed to account for herbicides active chemical varying properties and minimize its potential affect to water quality. BMPs will be incorporated into the project to protect water quality. BMP 5.10 requires a spill contingency plan consisting of predetermined actions to be taken in the event of a spill. Water contamination resulting from cleaning or disposal of pesticide containers would be prevented (BMP 5.11). Lastly, BMP 5.13 minimizes the risk of pesticide falling directly into water, or non-target areas from drifting during spray application.

These BMPs and DFs would effectively diminish the possibility of off-site transport via runoff and limit herbicides from entering surface waters through overland flow. Therefore, the proposed treatments with chemicals and its metabolites are not expected to accumulate or negatively affect water quality in the project area or downstream.

Water Quality Monitoring Studies

The results of fifteen separate water monitoring reports written by hydrologists and geologists on Region 5 forests were summarized in a paper entitled “A Review and Assessment of the Results of Water Monitoring for Herbicide Residues For The Years 1991 to 1999” (Bakke 2001). These reports documented the results of over 800 surface- and ground-water samples taken for reforestation and invasive plant treatment projects that used three herbicides (glyphosate, hexazinone, and triclopyr).

Glyphosate was used on four Forest on eight projects and monitoring samples were collected from 1991-2000. All the projects had various buffers, one projects buffer was as small as 10 feet and it was found that all post-treatment water samples had non-detectable levels of Glyphosate except for one

project. One project on the Angeles National Forest had one detection sample out of 13, 15 parts per billion (ppb) which below any level of concern for human health or aquatic resources (Bakke 2001). Triclopyr was used on five projects on three Forests. Where Triclopyr was used with buffers of 10 to 15 feet, there were three projects where detections occurred. The levels of detection ranged between 0.1 to 1 ppb where specified. One detection of 82 ppb was determined to be from not establishing a buffer on an ephemeral channel. The other detection was on a project with buffers of 10 feet; it had detection during winter storms of 0.63 parts per million (ppm) and 0.6-0.7 ppm. Another project with buffers of 15 feet had a single detection of 1 ppb (Bakke 2001). These detections are considered low and below toxicity levels for aquatic species. To be toxic for the rainbow trout for instance, would require a 96 hour exposure at 117ppm, not ppb. Triclopyr has been shown to have a half-life of 1.3 days in river water (Ganapathy 1997).

Soil Analysis

The soils analysis looked at the soils hydrologic function, its ability to support plant growth and filtering-buffering function. The qualitative analysis will disclose the existing condition and compare that to the proposed activities. Effective soil cover will be given a qualitative rating for soil stability as a part of the soil hydrologic function and its ability support plant growth. Fine organic matter will be given a qualitative rating for surface organic matter as part of soils ability to support plant growth. Compaction will be given a qualitative rating for soil strength as part of the soil's ability support plant growth. Using soil structure and percent soil erosion a condition rating will be given to soil structure and Marco-porosity.

Soil Assessment and Assumptions

Soil surveys for the project were conducted in June of 2021. Soil survey units were selected by looking at the soil types, fire history, initial erosion hazard rating, and past management activities to determine were to survey. The data collected were sample points in proposed treatment units along systematic randomized transects, which were designed to sample the geographic and topographic extent and variation of those proposed treatment units. Transects were randomly located using a topographic map and modified in the field to ensure collection of the necessary information. The data was collected systematically along each transect. Each survey had a minimum of two transects and a total of 60 sample points. Information on slope, soil compaction, soil cover, soil disturbance, soil displacement, and surface erosion were recorded at each sample point. Soil texture and its structure were recorded every 10th point. Photos were taken to capture the general condition of the survey area or any potential soil concerns such as rills and gullies. The soil indicators below will be rated as good, fair, or poor in relation to meeting desired condition.

Support for Plant Growth and Soil Hydrologic Functions

Soil Stability

An adequate level of soil cover is maintained to prevent accelerated erosion, and erosion prevention measures are effectively implemented following soil disturbing activities.

Percent Effective Soil Cover

- Duff and litter greater than ½ inch in depth, surface gravels greater than ¾ inch in diameter, woody debris greater than ¼ inch in diameter, and living vegetation count as effective soil cover.
- The Plumas National Forest Land and Resource Management Plan (LRMP) states soils with low, moderate, high, and very high Erosion Hazard Ratings (EHRs) require a minimum of 40 percent, 50 percent, 60 percent, and 70 percent effective soil cover, respectively. Units with low EHRs require a minimum of 40 percent effective soil cover under the LRMP but for this analysis the minimum will be set at 50 percent due to the Region Five National FSM Supplement for Soil Management indicates that soil cover is 50 percent or greater for desired condition.
- Soils that were surveyed would have their EHRs recalculated and the ones that weren't the EHRs would be set for moderate at 50 percent effective soil cover.
- The desired condition is to have the effective soil cover sufficient to meet the EHR requirements.
- Good rating for soil stability will be given if effective soil cover is found to be at or greater of desired condition. Signs of erosion are not visible or very limited in degree and extent.
- Fair rating for soil stability will be given if effective soil cover is within 5-15 percent of desired.
- Poor rating for soil stability will be given if effective soil covers falls well below desired condition (greater than 15 percent).

Support for Plant Growth

Surface Organic Matter

The amount of organic material on top of the mineral soil is maintained at levels to sustain soil microorganisms and provide for nutrient cycling. Fine organic matter is big component of effective soil cover. The measure that will be used for surface organic mater will be effective soil cover. Percent fine organic matter will be looked at to determine the nature of the effective soil cover. Fine organic matter is duff and litter greater than ½ inch in depth and woody debris between ¼ to 3 inches in diameter.

Percent Effective Soil Cover

- Good condition (desired condition) for surface organic matter is when the size, amount and distribution of organic matter present is within the range of the ecological type and normal fire return interval. If effective soil cover meets the requirement its desired condition and a significant portion of it is fine organic matter, then the desired condition for surface organic matter is met.
- Fair condition for surface organic matter is when fine organic matter falls below or above the desired condition. The departure can either be a deficiency or excess. For this project if effective soil cover is rated as fair then surface organic matter will be rated as fair.

- Poor condition for surface organic matter is when major portions of the area do not meet the desire condition. The departure can either be a deficiency or excess. If the effective soil cover is well below desired condition, then surface organic matter will be rated as poor because fine organic matter by default will be less than effective soil cover. The area won't have sufficient levels of organic matter to sustain soil microorganisms and provide for nutrient cycling.

Soil Organic Matter (SOM)

The amount of organic matter within the mineral soil, indicated by the color and thickness of the upper soil horizon, is within the normal range of characteristics for the site, and is distributed normally across the area.

Percent Displacement

- Soil displacement is evaluated and graded pass or fail - yes or no at every sample point. displacement is defined here as the removal or loss of either 4 inches of topsoil or more than ½ of the humus-enriched topsoil (A horizon) from a contiguous area greater than 100 square feet.
- Good condition is when localized areas of displacement may have occurred, but it will not affect the productivity for the desired plant species. If displacement is than 5 percent, then it is in good condition.
- Fair condition is when minor portions of the area, the upper soil layer has been displaced or removed to a depth and area large enough to affect productivity for the desired plant species. If displacement ranges from 5-15 percent, it is in fair condition.
- Poor condition is when major portions of the area have had the upper soil layer displaced or removed to a depth and area large enough to affect productivity for the desired plant species. Poor condition is when major portions of the area do not meet the desire condition.

Soil Strength

The soil strength level is conducive to a favorable rooting environment for the desired plant species. Some level of increase in strength compared to a natural undisturbed condition may not be undesirable.

Percent Compaction

- Soil compaction is determined at a depth of 4 to 8 inches at every sample point by inserting a spade or shovel into the soil. If the spade is inserted without difficulty the soil is non-compacted. If the soil is resistant to insertion of spade or shovel, a shovel-full of soil is removed and soil structure examined for indications of compaction (platy or massive soil structure).
- Good condition is when over most of the area the soil strength level is conducive to a favorable rooting environment for the desired plant species. If soil compaction is than 5 percent, it is in good condition for soil strength.
- Fair condition is when minor portions of the area, soil strength has increased in degree and depth such that it limits the growth of desired plant species. If soil compaction ranges from 5-15 percent, it is in fair condition for soil strength.

- Poor condition is when over major portions of the area soil strength has increased in degree and depth such that it limits the growth of desired plant species. Poor condition is when major portions of the area do not meet the desire condition for soil strength.

Soil Moisture Regime

The inherent soil moisture regime is maintained, especially in wet meadows and fens. If needed, propose projects that will restore the soil moisture regime. During land management project analysis evaluate whether the proposed activities will result in changes to the soil moisture regime, particularly in wet meadows and fens.

Acres of Wet Meadow and Fens Treated

- During hydrological mapping of project riparian features such as wet meadows and fens were recorded.
- If needed, propose projects that will restore the soil moisture regime.

Soil Hydrologic Function

The soil hydrologic function is the inherent capability of the soil to absorb, store and transmit water within the soil profile. The capability is dependent upon an adequate level of cover to reduce rainfall impact and runoff energy, stable soil structure, and sufficient macro-porosity to permit water infiltration and movement through the soil.

Soil Structure and Marco-porosity

Soil structure and macro-porosity (defined here as pores 1mm or larger) that is like the undisturbed, natural condition for the soil type and provides sufficient infiltration and permeability to accommodate precipitation inputs for the given climate. Soil surveys recorded at every 5th point soil texture and soil structure. Every time soil compaction was suspected the soil structure was recorded. Using soil structure and percent soil erosion a condition rating will be give to soil structure and Marco-porosity.

Percent Soil Erosion and Compaction

- Soil surveys at every point looked within a 37 ft radius for signs of rilling and gullying at least 20 feet in length.
- Good condition is when visually soil structure and macro-porosity are relatively unchanged from natural condition for nearly all the area. Signs of erosion or overland flow are absent or very limited in degree and extent. Infiltration and permeability capacity of the soil is sufficient for the local climate. If the average of soil compaction and erosion is less than 5 percent than it is in good condition.
- Fair condition is when minor portions of the area: soil structure and macro-porosity are changed; or platy structure and/or increased density evident; or overland flow and signs of erosion are visible. Infiltration and permeability capacity are insufficient in localized portions of the area. If the average of soil compaction and erosion is between 5 to 10 percent than it is in fair condition.

- Poor condition is when major portions of the area have reduced infiltration and permeability capacity indicated by soil structure and macro-porosity changes; or platy structure and/or increased density; or signs of overland flow and erosion. If the average of soil compaction and erosion is greater than 10 percent than it is in poor condition.

Qualitative Assessment of the Soils Filtering-Buffering Function

- Soil filtering and buffering capacity is the soils ability to protect water quality by immobilizing, degrading, or detoxifying chemical compounds or excess nutrients. The qualitative assessment will look at potential changes to soil filtering and buffering capacity between existing condition and proposed action.

Existing Condition

Soil surveys for the project were conducted in the month of June 2021. Soil survey units were selected by looking at the soil types, fire history, initial erosion hazard rating, and past management activities to determine were to survey. The proposed project is 250 acres, but the initial Sale Area Improvement (SAI) boundary was 776 acres (
Figure 1.) The soil surveys conducted covered the SAI boundary of the project. A total of 247 acres were surveyed for 32 percent coverage and is a representative sample of the conditions found throughout the project. Approximately 138 acres of the soil surveys overlap with the proposed 250-acre salvage for a total for 55 percent coverage. Approximately 201 acres were rated as high (84 percent) and 39 acres as moderate (16 percent) according to the Burned Area Reflectance Classification (BARC) GIS. The BARC GIS is a satellite-derived data layer of post-fire vegetation condition. The BARC has four classes: high, moderate, low, and unburned. This product is used as an input to the soil burn severity map produced by the Burned Area Emergency Response (BAER) teams. Therefore, the number presented here should be referred to as a Modified BARC severity estimate, not an estimate of Soil Burn Severity because there were not enough field visits to complete a proper Soil Burn Severity Map.

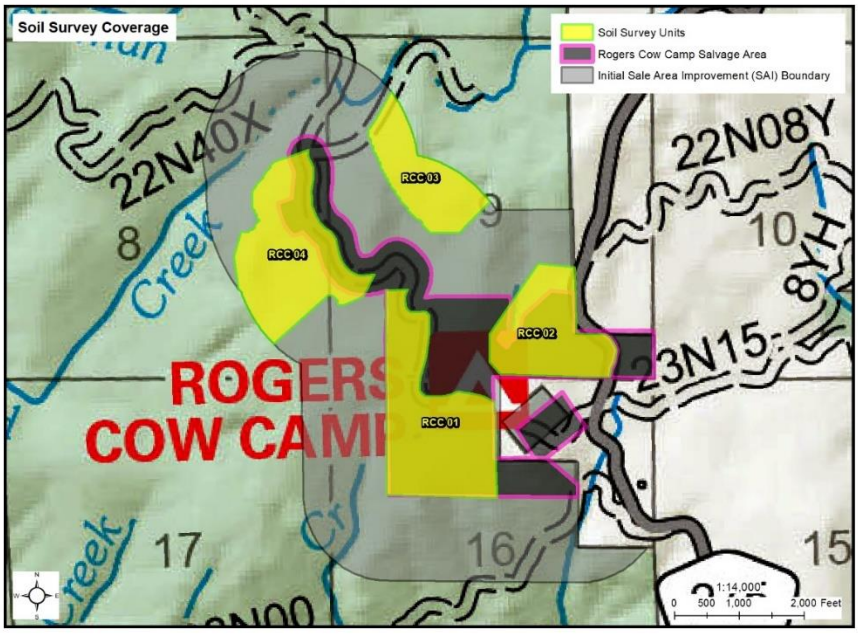

Figure 1. Soil Survey Coverage

Table 6 below shows the results of the soil surveys for the project. The projects desired percent effective soil cover is set at 50 percent after projects EHRs were calculated. Percent effective soil cover is met on 1 of the 4 units. Unit RCC 02 has an effective soil cover of 53 percent which meets the desired condition. Unit RCC 01 has an effective soil cover of 37 percent, RCC 03 has an effective soil cover of 37 percent and RCC 04 has an effective soil cover of 30 percent. The rating for soil stability is for the survey locations ranges from poor to fair-good as indicated in Table 6. However, at a landscape scale soil stability is rated as fair because within the SAI boundary the average percent effective soil cover is 42 percent.

Units RCC 03 and RCC 04 are rated as poor for surface organic matter due to soil stability being rated as poor. Insufficient effective soil cover means that surface organic matter won't be within the range of its typical size, amount and distribution for the ecological type and normal fire return interval of the project analysis area. Table 7 indicates the fine organic matter found in unit RCC 03 is 22 percent and RCC 04 is 5 percent. Unit RCC 01 is rated as fair-good for surface organic matter due effective soil cover is close to desired condition for soil stability. The fine organic matter for RCC 01 is 15 percent. Unit RCC 02 is rated as good for surface organic matter due to effective soil cover meeting the desired condition for soil stability. Fine organic matter for RCC 02 is 43 percent.

The 3 of the 4 units were found to have some form of soil displacement ranging from 12-30 percent. Units RCC 01 and RCC 04 are rated as poor for SOM. RCC 02 is rated as fair and RCC 03 as good. The average displacement is 15 percent therefore is rated as fair for SOM. Close inspection of the soil data indicates that units with higher displacement had typically a higher amount of surface erosion. The data does not indicate that past management activities resulted in the high displacement. The high displacement is associated with sheet wash erosion.

Soil compaction for the units that were surveyed were found to be on average 5 percent compacted. The range of soil compaction is from 0 percent to 12 percent. The compaction primarily was found on skid trails and landings from previous timber harvest activities. Units RCC 01 and RCC 04 were rated as fair. Units RCC 02 and RCC 03 were rated as good as indicated in Table 6.

Soil structure and Marco-porosity is rated as poor for units RCC 01 and RCC04. Units RCC 02 and RCC 03 is rated as good for soil structure and Marco-porosity (see Table 6 for exact percentages). Close inspection of the units that were rated as poor for soil structure and Marco-porosity is primarily due to the overland flow and erosion that was found.

The soils ability to filter and buffer chemical compounds or excess nutrients from degrading water quality is poor to fair. Soil surveys indicate that effective soil cover is from poor to good and the average effective soil cover is 42 percent. Fine organic matter is well below desired condition. Effective soil cover and fine organic matter are two components that are important to the soils ability to immobilizing, degrading, or detoxifying chemical compounds or excess nutrients (i.e. top soil runoff). Currently no known pesticides use, or chemical spills are known within the project that would degrade water quality.

Table 6. Existing Soil Condition Measures

Soil Survey Number	Dominant Soil Texture	EHR	Desired Effective Soil Cover	Actual Effective Soil Cover	Soil Stability Rating	Surface Organic Matter Rating	Displacement	Soil Organic Matter (SOM) Rating	Compaction	Soil Strength Rating	Soil Erosion & Compaction	Soil Structure and Macro-porosity Rating
RCC 01	Loam	Low	50%	47%	Fair-Good	Fair-Good	30%	Poor	12%	Fair	23%	Poor
RCC 02	Loam	Low	50%	52%	Good	Good	12%	Fair	3%	Good	2%	Good
RCC 03	Silty clay loam	Moderate	50%	37%	Poor	Poor	0%	Good	0%	Good	2%	Good
RCC 04	Loam	Moderate	50%	30%	Poor	Poor	17%	Poor	5%	Fair	11%	Poor

Table 7. Existing Soil Fine Organic Matter

Soil Survey Number	Fine Organic Matter
RCC 01	15%
RCC 02	43%
RCC 03	22%
RCC 04	5%

Proposed Project

Direct and Indirect Effects

In the first phase salvage will have minimal increases in soil compaction. Soil compaction is expected to be concentrated in existing and proposed skid trails, landings, and temporary roads. To keep soil compaction to a minimum a soil moisture LOP will be in place that would allow heavy equipment to operate only when soils are considered dry. The type of soil found throughout the project is primarily loam with some silty clay loam. Most of the project consists of loam soils which contain less clay content when compared to silty clay loam. The lower clay content helps minimize the potential for compaction. Mastication is another treatment that the soil compaction would be minimal because of the soil moisture LOP and type of soil texture. Mastication is part of the second and third phase of the project. The proposed activities just discussed with their design features should not push the soil strength rating to poor condition. Treatments such as hand cut, hand cut pile burn and underburn units are not expected to result in increases in soil compaction which are part of the second and third phase of the project.

It is difficult to predict precise treatment effects on forest floor, general trends are well established. The 2011 HFQLG Soil Monitoring Report presents the effects of this measure for over 100 units treated on the 3 National Forests that were implementing the HFQLG pilot project, including units on Plumas National Forest. Pre-treatment data collection started in 2001 and post-treatment data collection began in 2004. The total number of treatment units complied up to 2011 is 73 thinning units. According to the report, thinning unit's averaged 90 percent effective soil cover pre-activity and 83 percent post-activity (Young 2012). The HFQLG Soil Monitoring Reports demonstrate that mechanical thinning treatments such as those proposed under this project are likely to cause reductions in the areal extent of effective soil cover. Due to the projects 42 percent average for effective soil cover and the minimal expected loss of effective soil cover due to thinning, salvage in this case it's expected that all surveyed and non-surveyed units will not meet the standard (minimum) for effective soil cover. However, design features are in place to offset any loss of effective soil cover. Slash taken to the landings or piles should be minimized and left in place to improve effective soil cover. When cutting trees lop and scatter broken tops and limbs within 1 tree length of any stream. Were feasible scatter slash to increase coverage. Skid trails should add ground cover/slash between its waterbars and the outlets of the waterbars. Effective soil cover percentages should be 50 percent between waterbars and 70% at waterbar outlets.

The second and third phase of the project include various treatments such as mastication, hand cut pile burn, grapple pile, and underburn to treat and maintain fuels. These treatments are less disturbing to soils across the projects landscape when compared to the mechanical salvage component of the project. Mastication is more likely to increase effective soil cover and fine organic matter because it rearranges the fuels down to the ground as copped up organic matter. Hand cut pile burn will decrease effective soil cover and fine organic matter, but it will be minimal because those reductions are isolated to those piles. Grapple pile is anticipated to be the more disturbing treatment to effective soil cover and fine organic matter because it rearranges the fuels into larger piles which are eventually consumed by fire.

Underburning would occur under prescribed conditions that would not result in the complete combustion of the duff and litter layer. Instead it will burn in a mosaic pattern only consuming the fine organic matter where the fire went through. The underburning within the RCA buffers would have a mosaic pattern due to the varying moisture conditions and the impacts should be minimal and not significant to effective soil cover. The BMP effectiveness was rated as 92 percent for underburn units for 2011. The 2011 Best Management Practices Evaluation Program (BMPEP) Report found that the implementation and effectiveness of the BMPs for 2011 was at 100 percent and 97 percent, respectively (USDA Forest Service 2011b). Specific BMPs and design features will be in place to keep the soils functions working. It is expected that the soil stability and surface organic matter shall remain in good condition. Soil organic matter will range from good to fair condition.

The Long Term Soil Productivity (LTSP) study is a national and international study initiated in 1989 comprised of 62 study sites, including sites in the Sierra Nevada (Powers et al. 2005). The goals of the study are to gain understanding of potential soil productivity and effects of land management activities across a variety of sites. The national ten-year results indicate that bole only and whole tree fine organic matter removals, similar to the thinning treatments proposed for this project, have had no detectable effects on soil nutrition or biomass productivity. Significant reductions in soil carbon and nutrient availability were observed only for the extreme case of whole tree removal plus complete removal of all surface fine organic matter on the forest floor. However, the data trend indicated no general decline in biomass productivity across any of the fine organic matter removal levels. Given the modest and short-term reductions of fine organic matter that are expected due to the proposed treatments, those reductions would not significantly change the soil production potential for plant growth within the proposed units.

The twenty year LTSP study results for California determined that both whole tree harvesting and whole tree plus forest for floor removal did not significant affect aboveground biomass when compared to stem only harvesting (J. Zhang et al. 2017). Based on the twenty year results, there are no cumulative effects on the soils ability to support plant growth for the proposed treatments. All the surveyed units that have a proposed treatment are expected to continue to meet the desired condition for fine organic matter. However, even if the desired condition for organic matter cannot be achieved, it still will not significantly change the soil biomass productivity potential.

It is expected that post-treatment that soil structure and Macro-porosity will be rated as good because currently (existing condition) it's rated as good.

The implementation of the project with soils LOP and design features will minimize the impact to compaction and surface erosion. Currently the soil structure and Macro-porosity is rated as good and it's expected that it will remain good post-implementation due to the soils LOP and design features of leaving as slash as effective soil cover. The soil hydrologic function is expected to be in fair condition post-implementation.

Direct and Indirect of Effects of Chemical Treatments

To prevent the spread of Heterobasidion annosum (annosus) root disease sodium tetraborate decahydrate (a fungicide treatment) is proposed to be used. The treatment will only be applied during the

first phase of the project, which is the salvage component and not the other two phases. Sodium tetraborate decahydrate, also known as borax, is the active ingredient and sole constituent in Sporax. The compound borax is not applied as a liquid using backpack, broadcast or aerial spray methods and it is not applied directly to vegetation (USDA Forest Servic 2006). Borax is applied to freshly cut stump surfaces and is typically applied at a rate of one pound per 50 square feet of stump surface. This is equivalent to one pound of borax on 60 twelve-inch stumps (Sporax label, Wilbur-Ellis Company).

Boron is the agent of toxicological concern from Sporax and occurs naturally in soil (USDA Forest Servic 2006). According to the Human Health and Ecological Rick Assessment for Borax Final Report the effects of Sporax to soil microorganisms essential for formation of soil organic matter have not been characterized, and there is a risk of environmental exposures affecting nontarget microorganism (USDA Forest Servic 2006). However, given the atypical application method for Sporax, widespread exposures are not likely, and the risk of effects to soil indicators is minimal. The use of borax will have no significant direct, indirect, and cumulative effects to the soils ability to filter and buffer any chemical compounds.

After planting, the use of herbicides will be an option to control competing vegetation (target species would be primarily the shrub species ceanothus, manzanita, deer brush, Himalayan blackberry and other species as necessary). The herbicides proposed are glyphosate and triclopyr. These sites would be treated with herbicides up to three times over a period of approximately a decade. Treatments would occur when plants are actively growing. The following are these herbicides interactions with soils.

Glyphosate binds readily with soil particles, which limits its movement in the environment (Tu et al. 2001). Therefore, has little potential for leaching or runoff due to its very high adsorption to soils. Glyphosate rapidly and tightly binds to soil. There is little potential for leaching or runoff due to its very high adsorption to soil. As a result, glyphosate becomes inactive as an herbicide upon contact with the soil. Glyphosate is degraded via microbial activity. It has a half-life of 47 days (NPIC 2010).

Triclopyr was reported to have a field half-life of 40 to 46 days in soil, a water solubility rating that ranges from 440 to 8,220 mg/L, and an intermediate to minimal leaching potential. Triclopyr appears to variably persist in soil, with minimal mobility and minimal leaching evident in field studies. Triclopyr is adsorbed primarily to organic matter particles in soil. The organic matter content is the primary factor in the degree of soil adsorption and is not characterized as strong (SERA, 2011). Toxicity data on soil-micro-organisms is limited with triclopyr. The projected maximum concentrations under the proposed application rates would be far below potentially toxic levels, therefore the potential for substantial effects on soil-micro-organisms appear to be low (SERA 2011).

The degree to which soil cover decreases because of chemical application is hard to predict. However, design features are in place to mitigate any significant soil cover loss (see Management Requirements Table). The level of soil cover is a proxy for the level of organic material that can absorb applied herbicides. Thus, the soil cover works to lessen herbicide runoff and adsorption for decomposition by soil microbes – the main fate for herbicides (Bollag and Liu 1990). Due to the application rates and project design features, direct and indirect effects would be minimal or negligible. Consequently, there would be very little risk of any cumulative effects to soils at the project site.

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